Annals of Nuclear Medicine Vol. 17, No. 3, 245–248, 2003

Tc-99m depreotide SPECT demonstrates photon-deficiency in the thoracic vertebrae after adjunct radiation therapy of lung cancer: Correlation with MRI and bone scintigraphy

Wei-Jen SHIH and Charl VAN WYK

Nuclear Medicine Service and Radiology Service, Lexington VA Medical Center and Department of Diagnostic Radiology, College of Medicine, University of Kentucky, Lexington, KY, USA

Fifteen months after right lobe lobectomy with adjunctive radiation therapy for squamous cell carcinoma, a patient 53-yr-old man underwent Tc-99m depreotide chest single photon emission tomography (SPECT). In addition to two focal areas of abnormally increased uptake in the right lung, the Tc-99m depreotide SPECT showed cold areas in the middle thoracic vertebrae. Photopenic areas in the 6th and 7th thoracic vertebrae were shown on a bone scintigraphy. T1 weighted magnetic resonance imaging (MRI) of the spine showed fatty replacement of the marrow and Schmorl's nodes involving the 5th to 11th thoracic vertebrae. The vertebrae are normally visualized in Tc-99m depreotide SPECT imaging study, and lung tumor is usually somatostatin receptor positive with demonstrable activity in the lung. Absent uptake in the vertebrae in the fatty replacement of the marrow and multiple and giant vertebral Schmorl's nodes in the correspondent vertebrae in MRI may reflect visualization of vertebrae due to Tc-99m depreotide localizing in the bone marrow. Of the three imaging modalities, MRI showed the widest areas of thoracic vertebral involvement. One should be aware that a cold lesion in the vertebrae on Tc-99m depreotide imaging study may result from irradiation and may indicate the presence of a benign lesion in the bone marrow.

Key words: Tc-99m depreotide, squamous cell carcinoma, bone scintigrapy, SPECT (single photon emission tomography), MRI (magnetic resonance imaging), Schmorl's node, photon-deficient area, bone marrow, radiation therapy

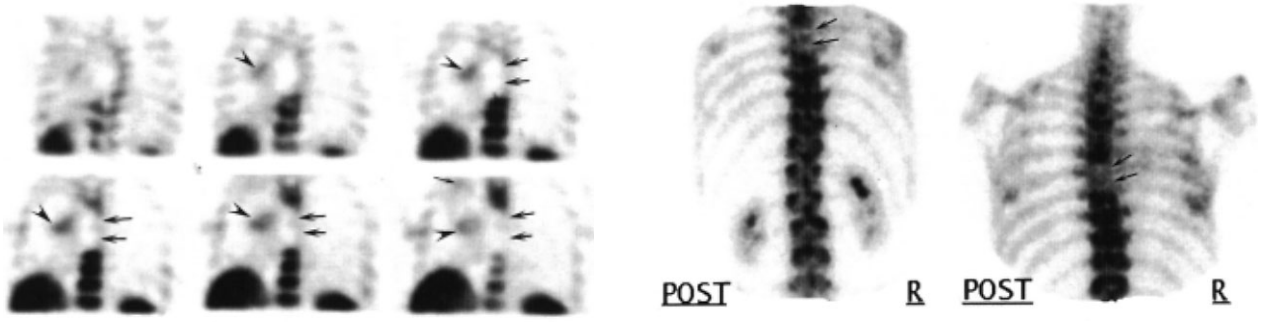
REPORT A CASE

A 53-year-old man with squamous cell carcinoma of the right lung, 15 months after right lower lobectomy and adjuvant irradiation, was referred for Tc-99m depreotide lung single photon emission tomography (SPECT) for evaluation of tumor recurrence. The patient had undergone right lower lobe lobectomy (RLL) and the tumor was confirmed to be squamous cell carcinoma. He was staged as having a T2 N0 M0, stage IB squamous cell carcinoma. Due to a positive resection margin, he underwent post-operative adjuvant radiotherapy and received 32 fractions of accumulation dose 64 Gy. Radiation field was focused on the tumor mass in the right lower lobe of the lung. The Tc-99m depreotide SPECTs showed two foci of increased uptake in the right lung and a large vertical and longitudinal area of absent uptake in the middle thoracic vertebrae, and decreased activity in the bilateral posterior ribs, being worse on the right side (Fig. 1A). Because of cold lesions in the thoracic vertebrae, the patient underwent bone scintigraphy two months after Tc-99m depreotide SPECT. Tc-99m HMDP bone scintigraphy of the thorax showed photopenic areas in the 6th and 7th thoracic vertebrae (Fig. 1B). For further evaluation of the thoracic vertebral lesions, MRI was done 2 weeks after the bone scan; T1 weighted images (Fig. 2) showed increased marrow signal in the 5th to 7th thoracic vertebrae as well as in the

Received December 2, 2002, revision accepted March 6, 2003.

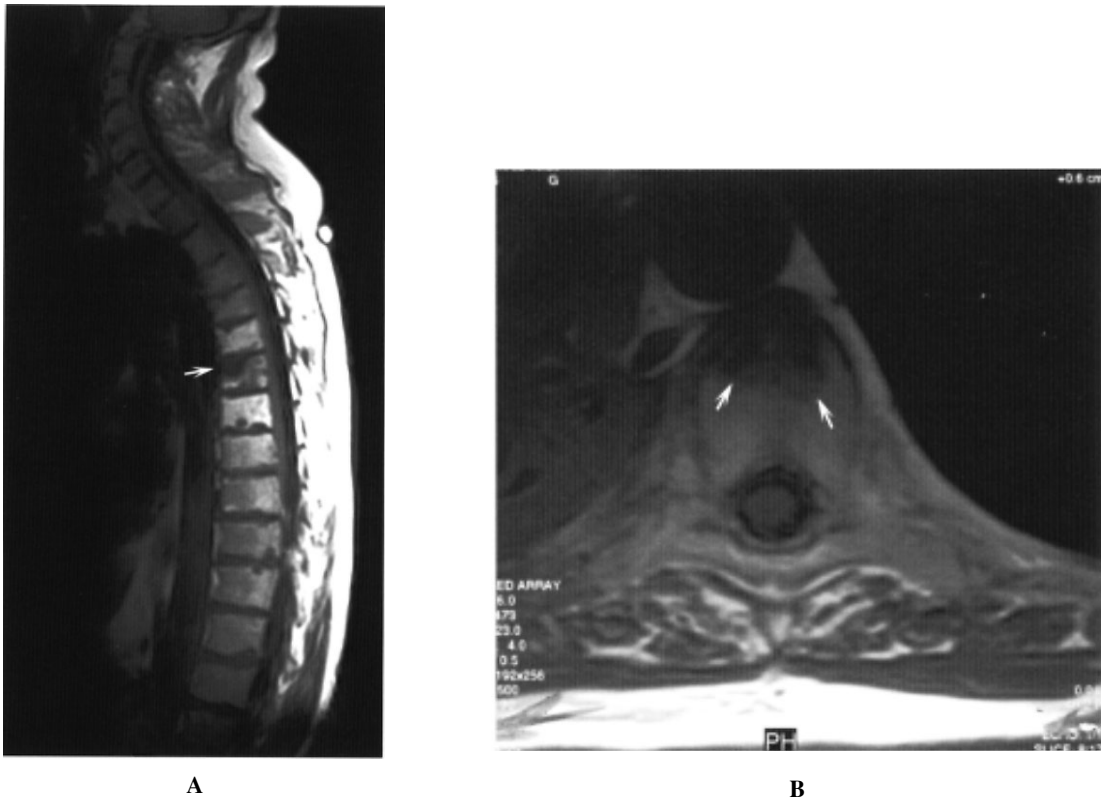
For reprint contact: Wei-Jen Shih, M.D., Nuclear Medicine Service, Lexington VA Medical Center, 1101 Veterans Dr., Lexington, KY 40502, USA.

E-mail: wei-jen.shih@med.va.gov



A B

Fig. 1 A: Tc-99m depreotide SPECTs show two foci of increased uptake in the right lung, as indicated by an arrowhead and one smaller arrow, and an absent uptake area in the 5th to 8th thoracic vertebrae as indicated by larger arrows. In addition, posterior ribs of both sides appear to be decreased activity and worse in the right posterior ribs. B: Posterior Tc-99m HMDP bone scintigraphy of the thorax done two months later shows photopenia areas in the 6th and 7th thoracic (T-6 and T-7) vertebrae. There is slightly narrowed the intercostal space between the right posterior 5th and 6th ribs.



A B

Fig. 2 T1 weighted images showed increased marrow signal in 5th to 7th thoracic vertebrae and in the superior portion of the 8th thoracic vertebra and posterior aspects of the 9th to 11th thoracic vertebrae. The pattern or distribution and linear appearance of increased signal is consistent with prior radiation with fatty marrow replacing the residual red marrow. Multiple Schmorl's nodes are noted. Depression of the anterior aspect of the T-6 probably represents a large Schmorl's node.

superior portion of the 8th thoracic vertebra; there was also mildly increased signal in the posterior aspects of the 8th to 11th thoracic vertebrae. The pattern or distribution and linear appearance of increased signal are consistent with prior radiation, with fatty marrow replacing the residual red marrow. Multiple Schmorl's nodes are noted. Depression of the anterior aspect of the 6th thoracic vertebra probably represents a large Schmorl's node.

DISCUSSION

Tc-99m depreotide, an amino acid peptide binding for somatostatin receptors type 2, 3, and 5, has a high affinity to lung cancer. Chest Tc-99m depreotide SPECT is currently used being for evaluation of solitary pulmonary nodules in patients with suspected lung cancer.[1–3] Normal localization of this agent in the organs includes the liver, spleen, and bone/bone marrow. In Tc-99m depreotide thoracic imaging study, the sternum, ribs and vertebrae are well visualized[4]; the mechanism of this bone structure visualization has been proposed to be localization in the bone/marrow.[4] Because of normal localization in the vertebrae of the thorax, regardless of the mechanism, vertebral uptake has been used as a standard of internal control to quantify solitary pulmonary nodules for the differentiation of benign from malignant lung lesion(s).[5]

Schmorl's nodes and fat replacement of the red marrow may have contributed to our patient's photon-deficiency in the thoracic vertebrae on Tc-99m depreotide SPECT. A Schmorl's node is the herniation of disc substance through the cartilaginous plate of the intervertebral disc into the body of an adjacent vertebra.[6,7] Though large Schmorl's nodes are unusual entities, 6 patients with giant cystic Schmorl's node have been reported.[8] Vertebral photopenia on In-111 labeled WBC scintigraphy in Schmorl's nodes on MRI has been reported.[9] Our patient's multiple and large Schmorl's nodes in the thoracic vertebrae alone certainly contributed to photon-deficiency in the thoracic vertebrae on Tc-99m depreotide SPECT and to some extent in bone scintigraphy.

In addition to the Schmorl's nodes, our patient's fat tissue replacement of the red marrow secondary to irradiation accounted for the photon-deficient findings; because our patient had adjuvant received irradiation after his RLL lobectomy 15 months preceding the Tc-99m depreotide SPECT, bone scintigaphy, and MRI. The MRI findings of increased signal and red marrow being replaced by fatty tissue in the thoracic vertebrae reflect the irradiation effect on the marrow. Absence of the normal marrow tissue or destruction of the marrow/ bone accounted for our patient's cold lesions (absent uptake) in the mid-thoracic vertebrae, from the 5th to 8th thoracic vertebrae and the posterior ribs especially on the right posterior ribs on Tc-99m depreotide. Although bone scans also showed photopenia in the 6th and 7th thoracic vertebrae compared with Tc-99m depreotide SPECT imaging, the cold areas were less apparent and less extensive on bone scan. The discrepancy between the Tc-99m depreotide and Tc-99m HMDP bone SPECTs findings in the thoracic vertebrae and ribs may be explained by the following: The mechanism of radiotracer localization in a bone scan depends on osteoblastic activity of the bony lesion; visualization of bone structures such as thoracic vertebrae and ribs on Tc-99m depreotide SPECT is most likely dependent on Tc-99m depreotide localization in the bone marrow. It is understandable that bone marrow is more sensitive to irradiation than is bone. This would account for our patient's discrepant findings between Tc-99m depreotide and Tc-99m HMDP SPECTs.

In the comparison between Tc-99m depreotide SPECT and MRI, MRIs are near compatible respective bone marrow abnormality, but MRI's abnormalities involved the 5th to 11th vertebrae, more extensive bone marrow involvement. These abnormal findings of the two imaging modalities reflect that bone marrow is a key demonstrable abnormality in MRI and Tc-99m depreotide SPECT imaging studies. Thus, the abnormal photon deficient findings on Tc-99m depreotide in our case are unlikely a result of tumor invasion of the bone/bone marrow. In addition, a) metastatic deposit(s) in the thoracic vertebrae from primary carcinoma of the lung should be area(s) of increased uptake as in pulmonary primary; b) MRI would detect the deposit(s) in the marrow.

In summar of these imaging modalities, MR showed widest areas of the involvement to thoracic vertebrae. Abnormalities of the marrow on MRI may explain the depreotide bone structure defects due to Schmorl's nodes and fat replacement of the red marrow. Therefore we may also conclude that the mechanism of Tc-99m depreotide localization in the vertebrae depends upon marrow uptake. The cold lesions in the thoracic vertebrae of a lung cancer patient's Tc-99m depreotide lung SPECT may not necessarily be malignant. The discrepancy between the two imaging modalities is due to the fact that Tc-99m depreotide assesses the status of the integrity of bone marrow and bone imaging agent assesses the status of the osteoblastic activity.

REFERENCES

1. Morehead RS, Shih WJ. Tc-99m labeled somatostatin receptor binding peptide imaging for a pulmonary nodule. *Clin Nucl Med* 2001; 26: 910–912.
2. Blum J, Handmaker H, Lister-James J, Rinne NA. S multicenter trial with a somatostatin analog Tc-99m depreotide in the evaluation of solitary pulmonary nodules. *Chest* 2000; 117: 1232–1238.
3. Blum J, Handmaker H, Rinne NA. The utility of a somatostatin-type receptor binding peptide radiopharmaceutical (P829) in the evaluation of solitary pulmonary nodules. *Chest* 1999; 115: 224–232.
4. Shih WJ, Hirschowitz E, Bensadoun ES, Woodring J, Ryo YU, Kraman S. Biodistribution on Tc-99m Labeled Somatostatin Receptor-binding Peptide (Depreotide, NeoTec) Planar and SPECT Images. *Ann Nucl Med* 2002; 16: 213–219.
5. Bostaph A, Miliziano J, Bradley Y. Qualitative Analysis of Solitary Pulmonary Nodule Using Tc-99m Depreotide. *J Nucl Med* 2002; 43: 113p.
6. Schmorl G, Junghanns H. In: *The Human Spine in Health and Disease*. New York; Gune and Stratton, 1971.
7. Pfirrmann CW, Resnick D. Schmorl Nodes of the Thoracic and Lumbar spine: Radiographic-Pathologic Study of

Prevalence, Characterization, and Correlation with Degenerative changes of 1650 Spinal Levels in 100 Cadavers. *Radiology* 2001; 219: 368–374.
8. Hauger O, Cotton A, Chateil JF, Borg O, Moinard M, Diard F. Giant Cystic Schmorl's Nodes: Imaging Finding in Six Patients. *AJR* 2001; 176: 969–972.
9. Kirkwood ID, Quint DI, Haig A, Wahl RL. Painful Schmorl's node: another cause of vertebral photopenia on In-111 labeled leukocyte scintigraphy. *Clin Nucl Med* 1999; 24: 206–208.
10. Walters G, Coumas JM, Akins CM, Ragland RL. Magnetic resonance imaging of acute symptomatic Schmorl's node formation. *Pediatric Emergency Care* 1991; 7: 294–296.